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NITROSAMINES

VOLUME 7

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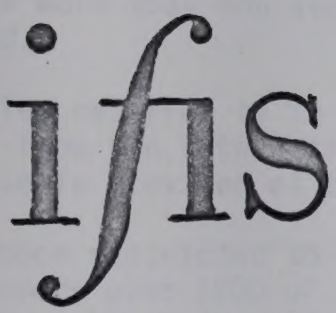

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INTRODUCTION

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have.

H. BROOKES
ASSISTANT EDITOR

1

[Refuting the formation of N-nitrosamines by the Maillard reaction.]
Kawabata, T.; Shazuki, H.
Journal of Food Science and Technology [Nihon Shokuhin Kogyo Gakkai-shi] 19 (6) 241-248 (1972) [7 ref. Ja, en] [Nat. Inst. of Health, Shinagawa, Tokyo, Japan]

Products or reaction of DL-alanine with D-glucose (pH 9.0, 100°C, 2 h) were analysed by GLC by use of (i) Chromosorb 101, (ii) Chromosorb W-20% Carbowax 1540-KOH, (iii) Chromosorb W-20% Carbowax 1540, or (iv) Chromosorb W-20% Versamide 900 column. A substance with retention time equal to that of dimethylnitrosamine was found in reaction products by use of (i) or (ii), but not by use of (iii) or (iv). In the former case, pyrazine or its derivative had the same retention time as dimethylnitrosamine. The other nitrosamines, i.e. dimethylnitrosamine, di-n-propylnitrosamine, di-n-butylnitrosamine, di-isobutylnitrosamine, and N-nitrosopyrrolidine were developed by TLC using a 2 solvent system, but none of these had R_f identical to those of any of the reaction products. GLC-MS showed the presence of pyrazine and absence of dimethylnitrosamine. The Maillard reactions of other amino acids with other sugars and ascorbic acid were carried out at different pH values. Dimethylnitrosamine was never found in any combinations examined. Brown coloured foods, soy sauce, miso, toasted bread, coffee, biscuit and chocolate were examined, but dimethylnitrosamine was never found; the test could detect 1 part/billion of dimethylnitrosamine. SKa

2

Inhibition of morpholine nitrosation by some phenolic wood smoke components.
Issenberg, P.; Virk, M.
Abstracts of Papers, American Chemical Society 168 AGFD 53 (1974) [En] [Eppley Inst. for Res. in Cancer, Univ. of Nebraska, Med. Center, Omaha, Nebraska 68105, USA]

Human exposure to carcinogenic N-nitroso compounds is influenced by amounts of precursor amines and nitrosating agents present in foods and other parts of the environment and by catalysts and inhibitors which may occur naturally or be added. Any factor which influences reaction rates will modify yields of N-nitroso compounds produced in foods or by intragastric reaction. Some phenolic compounds, previously identified in hardwood sawdust smoke and smoked foods, may be nitrosated and compete with amines for available nitrite. Phenol structure is an important factor in determining rate constants for C-nitrosation reactions. Ability of some phenolic components of smoked foods to inhibit nitrosation of morpholine was investigated. Model reaction mixture (pH 3.0) contained 0.01M morpholine, 0.02M sodium nitrite, and 0.02M phenol; 0.02M ascorbic acid was employed as reference inhibitor. Reaction time was 90 min. Under these conditions, nitrosomorpholine yield was 30% in uninhibited mixture. Phenol, 2-methoxyphenol, 2-methoxy-4-methylphenol, 2,6-dimethoxyphenol, and ascorbic acid provided 15%, 71%, 81%, 93%, and 96% inhibition, respectively. Since many nitrite cured foods are smoked, influence of smoke components on nitroso compound formation must be thoroughly evaluated. AS

3

The determination of total non-volatile nitrosamines in microgram amounts. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]
Walters, C. L.; Fueggle, D. G.; Lunt, T. G. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 53-58 ISBN 90-220-0463-5 (1974) [7 ref. En] Wageningen, Netherlands [Biochem. Section, BFMIRA, Leatherhead, Surrey, UK]

A selective method for determination of total non-volatile nitrosamines and nitrosamides in foods is described. Food samples are dried (preferably freeze-dried) and suspended in approx. 200 ml dry methylene chloride; dry N_2 is then bubbled through the suspension to displace damp air. 5 ml of a 25% solution of thionyl chloride is then added to denitrosate the nitrosamines or nitrosamides; the resulting product (presumably nitrosyl chloride) is then volatilized by a stream of N_2 and collected in a trap containing 5 ml of 100% (w/v) aqueous NaOH solution. To determine the nitrite formed in the trap, 1 ml of sulphanilamide solution (5% in conc. HCl, diluted with 3 vol. of water) is added, followed by 1 ml conc. HCl to lower the pH for diazotization. Colour development occurs following addition of 1.0 ml N-(1-naphthyl) ethylenediamine dihydrochloride (0.1% aqueous solution); nitrite is determined by optical density measurements at 540 nm. The nitrite yield from nitrosamines generally approximated to that achieved by denitrosation with hydrobromic acid in glacial acetic acid. Of other organic N compounds tested, none gave a significant nitrite yield after treatment with thionyl chloride. In the absence of water, little or no interference from inorganic nitrite occurs. Advantages claimed for the method include specificity, absence of an extraction step, and high sensitivity. AJDW

4

Determination of volatile amines and amine oxides in food products. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]
Ruiter, A. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 37-42 ISBN 90-220-0463-5 (1974) [8 ref. En] Wageningen, Netherlands [Inst. for Fishery Products TNO, Ijmuiden, Netherlands]

A method for determination of volatile dialkyl and trialkylamines and amine oxides in foods is

described. Samples are extracted with trichloroacetic acid solution and the extract is filtered. Amines are then separated by steam distillation, collected in HCl, and concentrated by evaporation. The conc. distillate is then adjusted to pH 10-11, and separated by GLC on Carbowax 400 + polyethylene imine. Trimethylamine and dimethylamine may be determined at concn. <1 mg/kg; for max. recovery of dimethylamine during steam distillation, it is necessary to add ethylamine as a distillation aid. Amine oxides may be determined by the above method after initial reduction to the corresponding amine by reaction with $TiCl_3$. Values for the concn. of trimethylamine, dimethylamine, trimethylamine oxide and total volatile bases in tomato juice, orange juice, Gouda cheese, bananas, minced meat (pork + beef, 1:1), canned mackerel, canned herrings, Maatjes herring, fresh cod, cooked cod and fried whiting are given. The risk of formation of nitrosamines in fish products is briefly discussed. AJDW

5

Determination of volatile nitrosamines: a review.
In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]
Eisenbrand, G. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 45-52 ISBN 90-220-0463-5 (1974) [45 ref. En] Wageningen, Netherlands [Inst. für Toxicologie und Chemotherapie, Deutsches Krebsforschungszentrum, Postfach 449, D6900, Heidelberg, Federal Republic of Germany]

Various aspects of the analysis of volatile N-nitrosamines in foods are discussed, including: isolation (by solvent-extraction or distillation methods); further purification (by TLC or column chromatography); and methods of detection and estimation (direct determination of intact nitrosamines, and methods based on formation and determination of derivatives.) AJDW

6

[Conversion of nitrosamines to nitramines for gas chromatographic analysis.]
Toda, K.; Izaki, Y.; Itokawa, T.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **14** (6) 561-564 (1973) [7 ref. Ja, en] [Inst. of Public Health, Higashi-Takadacho, Mibu, Nakagyo-ku, Kyoto, Japan]

The reproducible determination of nitrosamines after conversion to nitramines by peroxytrifluoroacetic acid is described. Optimum conditions for conversion were 120 min at 40°C. TM

7

Ascorbate and nitrosamine formation in cured meats. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]
Greenberg, R. A. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 179-185 ISBN 90-220-0463-5 (1974) [20 ref. En] Wageningen, Netherlands [Swift & Co., Res. and Development Center, Oak Brook, Illinois 60521, USA]

The possible significance of incorporation of ascorbate in nitrite-cured meat products (especially bacon) is discussed on the basis of literature data. Aspects considered include: occurrence of nitrosamines in cured meats; use of ascorbate as a curing adjuvant; ascorbate as a nitrosation preventive; possible use of ascorbate for control of formation of nitrosamines (especially nitrosopyrrolidone) in bacon; and effects of high ascorbate concn. on inhibition of Clostridium botulinum by nitrites. AJDW

8

The role of lean and adipose tissue on the formation of nitrosopyrrolidine in fried bacon.
Fiddler, W.; Pensabene, J. W.; Fagan, J. C.; Thorne, E. J.
Journal of Food Science **39** (5) 1070-1071 (1974) [15 ref. En] [USDA, E. Regional Res. Center, Philadelphia, Pennsylvania 19118, USA]

Nitrosopyrrolidine (NO-Pyr) has been found in fried whole bacon and in cooked-out fat. When lean and adipose tissue were fried separately under the same conditions of frying, NO-Pyr was found in adipose tissue residue and in cooked-out fat, but not in lean tissue or Crisco (hydrogenated vegetable oil) in which it was fried. Therefore, NO-Pyr precursor is present primarily in adipose portion of bacon. No NO-Pyr was found in ham, Canadian bacon, or beef bacon-like products. The collagen present in bacon adipose tissue is postulated as a source of presursors responsible for NO-Pyr production. IFT

9

[Determination of nitrosamines in foods. I.]
Kann, Yu. M. [Kann, J.]; Kask, K. A.; Tauts, O. V.; Raya, K. K. [Raja, K.]
Tallinna Poliitehnilise Instituudi Toimetised, A No. 331, 109-116 (1973) [33 ref. Ru, en]

It is considered on the basis of literature data and tests carried out by the authors on smoked fish that GLC with flame-ionization detector is the method of choice for nitrosamine determination in foods. SKK

10

[Nitrosamines in foods. Formation in vitro.]
Cantoni, C.; Renon, P.
Industrie Alimentari 13 (10) 95-97 (1974) [30 ref. It] [Istituto Ispezione Alimenti Animali, Univ. di Milano, Italy]

11

[Study of nitrosamines in foods. I. Distribution of secondary amines and nitrites.]
Yim, T.-K.; Yoon, M.-C.; Kwon, S.-P.
Korean Journal of Food Science and Technology 5 (3) 169-173 (1973) [29 ref. Ko, en] [Dept. of Preventive Med. & Public Health, Coll. of Med., Yonsei Univ., Korea]

In this report the amounts and distribution of secondary amines and nitrites in basic Korean foods, kim-chi, fish, fish roe, sausages, canned fish foods and fish sauces (salted fish) were studied. Nitrite contents were low in most of the foods except sausages. Secondary amines were low in kim-chi and fish, but high in fish sauces, fish roe and canned fish foods. The result of this study suggests that the possible formation of carcinogenic nitrosamines during manufacture, storage and cooking of all Korean foods should be studied. AS

12

A review of the nitrosamine problem in cured meats. [Review]
Rogers, R. W.
Food Product Development 8 (6) 40, 42, 44-45 (1974) [25 ref. En] [Animal Sci. Dept., Mississippi St. Univ., Mississippi, USA]

13

[Nitrates, nitrites and nitrosamines in flesh and viscera of calves fed with milk substitutes containing nitrates.]
Cantoni, C.; Renon, P.; Acqua, V. l'
Archivio Veterinario Italiano 25 (1/2) 21-27 (1974) [21 ref. It, en, fr, de] [Istituto di Ispezione degli Alimenti di Origine Animale, Univ., Milan, Italy]

The effects of feeding milk replacers containing (i) 410 mg/kg or (ii) 937 mg/kg added nitrate on the nitrate, nitrite and nitrosamine concn. in liver or muscle (biceps femoris) tissue of calves were investigated. 21 Black and White calves received each level of dietary nitrate from birth up to slaughter. Liver and muscle tissue samples from (iii) 12 animals fed a normal diet were also analysed. Tables of results are given. Mean values for nitrate, nitrite and nitrosamine concn. in liver tissue were, respectively (mg/kg): (i) 19.0, 0 and 0.009; (ii) 24.5, 0 and 0.027; (iii) 0, 29.4 and 0.004. Corresponding values for muscle tissue were: (i) 4.4, 27.4 and 0; (ii) 1.7, 23 and 0.014; (iii) 1.7, 7.2 and 0. AJDW

14

[Nitrosable amines in foods of animal origin.]
Cantoni, C.; Acqua, V. l'; Cattaneo, P.
Archivio Veterinario Italiano 25 (3/4) 113-119 (1974) [23 ref. It, en, fr, de] [Istituto di Ispezione degli Alimenti di Origine Animale, Univ., Milan, Italy]

The nitrosable amine concn. in samples of pigs' liver, calf liver, beef liver, horse liver, fresh ham, pork loin, cured ham, various types of sausage (salami, mortadella, coppa, wurstel, salsiccia), canned meat, cheese (gorgonzola and robiola), fish meal and meat meal were determined by colorimetry and/or GLC. Tables of results are given. Fish meal had a nitrosable amine concn. ≤242.6 mg/kg; the other foods studied contained ≤3.3 mg/kg. Dimethylamine was the only nitrosable amine detected in all the samples except fish meal, which also contained diethylamine and other (unidentified) nitrosable amines. AJDW

15

Isolation of volatile N-nitrosamines in edible vegetable oils and cooked bacon fat.
White, R. H.; Havery, D. C.; Roseboro, E. L.; Fazio, T.
Journal of the Association of Official Analytical Chemists 57 (6) 1380-1382 (1974) [4 ref. En] [Div. of Chem. & Physics, FDA, Washington, DC 20204, USA]

Volatile N-nitrosamines can be isolated from cooked bacon fat by the following procedures: the sample is distilled from alkaline solution and the nitrosamines are extracted with methylene chloride and cleaned up on a silica gel column (procedure A). The same procedures, preceded by an extraction with methylene chloride-sodium hydroxide, are used for isolation of N-nitrosamines from soybean oil samples (procedure B). GLC with the thermionic detector was used for the determinative step. Recoveries of 14 N-nitrosamines added to 25 g soybean oil samples at 10 and 20 parts/billion (ppb) ranged from 67 to 100% for procedure B; these recoveries were 5-10% higher than those from procedure A. No nitrosamines were detected in 4 commercial samples of soybean oil; however, they were found in cooked bacon fat at levels ranging from 45 to 207 ppb (μg/kg). AS

16

Determination of nitrates, nitrites and nitrosamines in cheeses. [Conference proceedings]
Laskowski, K.; Bierska, J.
XIX International Dairy Congress 1E, 514-515 (1974) [2 ref. En] [Inst. of Dairy Ind., Warsaw, Poland]

A clarified, aqueous-extract of the cheese is used. 0.125 ppm nitrate can be estimated from the pink colour developed with brucine in conc. H_2SO_4. If nitrite is detected with Greiss reagent, the aqueous

extract is steam-distilled at pH 8 (nitrosamines can be estimated by TLC in this distillate) and at pH 3.2-3.5; 0.01 ppm nitrite can be estimated in the 2nd distillate. JMD

17

The determination of N-nitrosoproline in cured meats.
Ivey, F. J.
Dissertation Abstracts International, B 35 (2) 879-880: Order No. 74-18272 (1974) [En] [Oregon St. Univ., Corvallis, 97331, USA]

A method for detn. of N-nitrosoproline (NP) in cured meats is described. NP is extracted with ethyl acetate from a cured meat/water slurry after addition of ammonium sulphamate and acid. This nitrosamino acid was then converted to the methyl ester, purified and determined by GLC-MS. Recovery was approx. 70%. A capillary column was used to coliform the presence of methylnitrosoproline in the extracts. NP was detected in various meat products. 5 of 6 bacon samples contained concn. of 13-46 ppb; a precooked ham slice contained 22 ppb and a breakfast beef samples contained 62 ppb. No NP was detected in canned chopped ham or wieners. It is suggested that NP could be a useful indicator of nitrosation in foods. Bacon cured in brines containing 800 and 1600 ppm nitrite contained 50 and 100 ppm residual nitrite respectively. Bacon receiving the lower level contained no NP; that receiving the higher level contained >100 ppb NP. Frying of bacon reduced the NP concn. by 86-100%, forming nitrosopyrrolidine; NP decomposition cannot, however, account for all the nitrosopyrrolidine formed in bacon during frying. AJDW

18

[Effect of processing on nitrosamine formation in meat products.] Einfluss der Verarbeitung auf die Bildung von Nitrosaminen in Fleischwaren.
Nagata, Y.; Mirna, A.
Fleischwirtschaft 54 (11) 1781-1786, 1789 (1974) [45 ref. De, en, fr] [Bundesanstalt für Fleischforschung, 8650 Kulmbach, Blaich 4, Federal Republic of Germany]

Effects of processing conditions on the concn. of nitrosamines in meat products are discussed on the basis of experimental and literature data. Nitrosamine formation was influenced mainly by heat treatment (sterilization, roasting, frying), not by pH. No effects of bacterial fermentation, increased salting, or increased addition of pepper or paprika were observed. No increase in nitrosamine concn. attributable to dry salting was observed, except in bacon (which contained 45 ppm nitrosamines, mainly dimethyl-, diethyl-, piperidine and pyrrolidine derivatives). No relationship was observed between residual nitrate or nitrite concn. and the nitrosamine content. Addition of ascorbic acid or its sodium salt, or glucono-δ-lactone resulted in increased concn. of nitrosopyrrolidone. Curing salt mixtures for reduction of nitrosamine formation in cured meats are suggested. RM

19

Effects of butylated hydroxytoluene alone or with diethylnitrosamine in mice.
Clapp, N. K.; Tyndall, R. L.; Cumming, R. B.; Otten, J. A.
Food and Cosmetics Toxicology 12 (3) 367-371 (1974) [8 ref. En] [Biol. Div., Oak Ridge Nat. Lab., Oak Ridge, Tennessee 37830, USA]

A pilot experiment involving the administration of BHT with or without the potent carcinogen diethylnitrosamine (DENA) to mice is reported. 18 month old mice given BHT at a dietary level of 0.75% for 16 months had 63.6% lung tumours compared with 24.0% in controls. Mice given DENA in the drinking water (average total intake 330 mg DENA/kg plus dietary BHT had more lung tumours per mouse than did controls or those given DENA or BHT alone. At 18 months the incidence of reticulum-cell sarcoma in both groups given BHT was significantly less than in groups not receiving BHT. VJG

20

Studies on possibility of formation of N-nitrosamines in cheeses. [Conference proceedings]
Kisza, J.; Przybylowski, P.; Dajnowiec, Z.
XIX International Dairy Congress 1E, 426-427 (1974) [3 ref. En] [Inst. of Food Eng. & Biotech., Univ. of Agric., Olsztyn, Poland]

Cheese made from milk containing 40-51 or 980 μg nitrate/100 g, and with or without a Streptococcus lactis + Str. diacetilactis + Lactobacillus casei starter, contained no nitrates after 4 wk ripening. Nitrates were still present in cheese ripened for 6 wk when made with a Str. lactis + Str. diacetilactis starter. Nitrosamine formation (detected in only 1 cheese) was inhibited by starters capable of breaking down nitrates. MEG

21

Investigations on the possible occurrence of nitrosamines in Lebanon bologna.
Palumbo, S. A.; Smith, J. L.; Gentilcore, K. M.; Fiddler, W.
Journal of Food Science 39 (6) 1257-1258 (1974) [14 ref. En] [USDA, E. Regional Res. Center, Agric. Res. Service, Philadelphia, Pennsylvania 19118, USA]

Examination of Lebanon bolognas produced commercially and in an experimented plant revealed absence of detectable levels of 6 volatile nitrosamines. Assays for pH, nitrite and nitrosamines were conducted daily during the fermentation and after 4 and 12 days storage at 5°C. IFT

22

Effect of additives on the formation of nitrosamines in meat curing mixtures containing spices and nitrite.

Sen, N. P.; Donaldson, B.; Charbonneau, C.; Miles, W. F.

Journal of Agricultural and Food Chemistry 22 (6) 1125-1130 (1974) [18 ref. En] [Food Res. Div., Health Protection Branch, Ottawa, K1A OL2, Canada]

Studies were carried out to determine the effect of an alkaline buffer and sodium ascorbate on the formation of N-nitrosamines in curing mixtures containing spices and nitrite. 4 samples of such premixes prepared with or without the buffer were analysed for nitrosamines after storage for 4-15 wk at 2 different temp. Buffering (at pH 7.5-8.2) markedly reduced the formation of nitrosamines but did not prevent it completely. Formation of appreciable levels (≤4 ppm) of nitrosamines was observed in most nonbuffered samples. Higher levels of nitrosamines were formed at 38°C than at room temp. Similar studies with 6 samples of premixes prepared with or without ascorbate indicated its ineffectiveness in preventing nitrosamine formation. Of 30 samples of various commercial premixes analysed 17 were positive for nitrosamines. The most commonly found nitrosamines were nitrosodimethylamine, nitrosopyrrolidine, and nitrosopiperidine, all of which are potent carcinogens. AS

23

Gas chromatographic-mass spectrometric determination of N-nitrosodimethylamine formed in synthetic and human gastric juice.

Lane, R. P.; Rice, R. H.; Bailey, M. E.

Journal of Agricultural and Food Chemistry 22 (6) 1019-1023 (1974) [19 ref. En] [Dept. of Food Sci. & Nutr., Univ. of Missouri, Columbia, Missouri 65201, USA]

An analytical procedure for determination of N-nitrosodimethylamine in human gastric juice is described. N-Nitrosodiethylamine is used as an internal standard to quantitate N-nitrosodimethylamine and high-resolution mass spectrometry is used to detect and confirm identity of the nitrosamine. This procedure could be useful for estimating levels of nitrosamines at 0.1 ppb. Glycine competed for nitrite in a reaction mixture containing nitrite, N-nitrosodimethylamine, and glycine in synthetic gastric juice. A mixture of amino acids retarded nitrosamine formation at pH 2.5 but not at other pH values studied. Meat extract from cooked pork also retarded nitrosamine formation at pH 2.5 and 4.5. AS

24

Quantitative determination of N-nitroso compounds by gas chromatography. [Conference proceedings]

Kawabata, T.; Ishibashi, T.; Matui, M.

IV International Congress of Food Science and Technology Abstracts of Papers 9a, 205 (1974) [En] [Dept. of Biomed. Res. on Food, Nat. Inst. Health, Kamiosaki, Shinagawa-ku, Tokyo 141, Japan]

A new method for gas chromatographic determination of such non-volatile N-nitroso compounds as nitroso sarcosine, nitroso proline and nitroso pipecolic acid has been devised. The principle of this method is based on the conversion of these non-volatile substances with diazomethane to gas chromatographable derivarives. The esterification rates of 3 nitroso amino acids were more than 95%, and the methylated derivatives can be determined by a gas chromatograph equipped with an alkali flame ionization detector on a column packed with 15% DEGS on Shimalite (60-80 mesh). The min. detection levels for the methyl esters was 1 ng. AS

25

Study on the carcinogenicity of lead arsenate and sodium arsenate and on the possible synergistic effect of diethylnitrosamine.

Kroes, R.; Logten, M. J. van; Berkvens, J. M.; Vries, T. de; Esch, G. J. van

Food and Cosmetics Toxicology 12 (5/6) 671-679 (1974) [13 ref. En] [Lab. of Toxicol., Nat. Inst. of Public Health, PO Box 1, Bilthoven, Netherlands]

A lifetime study (29 months) was carried out on the combined effects of As and the lung carcinogen diethylnitrosamine (DENA) in rats. In order to investigate whether sodium arsenate or lead arsenate is a carcinogen and whether any synergistic or additive action exists between DENA and Pb and/or As, rats were fed lead arsenate in the diet at 1850 or 463 ppm, sodium arsenate at 416 ppm, and 463 ppm lead arsenate or 416 ppm sodium arsenate in combination with DENA given in an intubated dose of 5 μg/day on 5 days/wk. At a level of 1850 ppm, lead arsenate was toxic and caused intra- and extrahepatic bile-duct lesions. Sodium arsenate showed no carcinogenic action at the dose level used. No additive or synergistic effect could be attributed to DENA, which also failed to induce tumours at the low dose level used, suggesting the possible existence of a no-effect level for this carcinogen. VJG

26

Formation of nitrosamines. I. Kinetic studies on the nitrosation of piperidine and morpholine.

Yamada, T.; Yamamoto, M.; Tanimura, A.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 15 (3) 201-205 (1974) [23 ref. En] [Nat. Inst. Hyg. Sci., 18-1, Kamiyoga 1-chome, Setagaya-ku, Tokyo, Japan]

Initial rates of formation of nitrosopiperidine (NP) from piperidine and sodium nitrite and of nitrosomorpholine (NM) from morpholine and sodium nitrite were proportional to [piperidine] $[NaNO_2]^2$ and [morpholine] $[NaNO_2]^2$, respectively, both at pH 4.2 and 3.0. The effect of SCN^- on the formation of NP was also studied. TM

27

C-nitrosation products in food. [Conference proceedings]
Knowles, M. E.; Gilbert, J.; McWeeny, D. J.
IV International Congress of Food Science and Technology Abstracts of Papers 9a, 214 (1974) [En] [Food Sci. Div., Min. of Agric., Fisheries & Food, Colney Lane, Norwich NOR 7OF, UK]

The reactions of nitrite with food components may give rise to the formation of trace amounts of nitrosamines but many other reactions may also take place, leading to quite different compounds. Investigations are reported on the possible formation of C-nitroso compounds from various substances present in cured food. These demonstrate that there can be reaction with the tyrosine residues of proteins, the phenols encountered in smoked cured meats and some permitted food colours. AS

28

[Nitrosamines in foods. Analysis, decomposition and formation. I. Methods of determination for model experiments.] Nitrosamine in Lebensmitteln. Beiträge zu Analytik, Abbau und Aufbau. I. Bestimmungsmethoden für Modellversuche.
Möhler, K.; Hallermayer, E.
Zeitschrift für Lebensmittel-Untersuchung und -Forschung 156 (4) 206-210 (1974) [18 ref. De, en] [Deutsche Forschungsanstalt für Lebensmittelchem., Munich, Federal Republic of Germany]

In a study of relatively simple methods for nitrosamine detn. in model experiments, the photometric methods of Eisenbrand & Preussmann [Arzneimittel-Forschung (1970) 20, 1513], Sander [Hoppe Seyeler's Zeitschrift für Physiologische Chemie (1967) 358, 852] and Ender & Ceh [FSTA (1971) 3 8C143] were evaluated. Only the 1st was found satisfactory. However, GLC after TLC separation is considered the method of choice. Semi-quantitative values found by such method for cooked ham showing signs of spoilage in refrigerated storage (apparently pickled with nitrate and containing 240 mg $NaNO_2$/kg when sound) and for 2 samples of mouldy raw sausage were respectively (mg/kg): nitrosodimethylamine, 0.04, 0 and 0; nitrosodiethylamine, 0.04, 0.12 and 0.20; nitrosodiisopropylamine, 0.02, 0.09 and 0.08; nitrosodipropylamine, 0.06, 0.23 and 0.12; nitrosodibutylamine, 0, 0, and 0; $NaNO_2$, 13, 4 and 9; and KNO_3 15, 78 and 6. SKK

29

Uncertainties about nitrosamine formation in and from foods. [Conference proceedings]
Tannenbaum, S. R.; Fan, T. Y.
Proceedings of the Meat Industry Research Conference pp. 1-10 (1973) [23 ref. En] [Dept. of Nutr. & Food Sci., Massachusetts Inst. of Tech., Cambridge, Massachusetts 02139, USA]

Nitrosamine formation in foods and/or in the stomach is discussed, with reference to literature data for the concn. of nitrosamines in various foods; mechanisms of nitrosamine formation; effects of pH, temp., amine type, catalysts and inhibitors on nitrosamine formation; acceleration of nitrosamine formation in the frozen state, due to concentration of nitrites and amines in the unfrozen liquid fraction; applications of model system results; and prediction of nitrosamine formation on the basis of nitrite concn., amine concn. and type, pH, temp. and reaction time. AJDW

30

Problems arising from the use of nitrites in food processing. [Conference proceedings]
Friedman, L.
Proceedings of the Meat Industry Research Conference pp. 11-20 (1973) [En] [Div. of Toxicol., FDA, Washington, DC 20204, USA]

Possible formation of nitrosamines by reaction of amines with nitrite added to foods is discussed, with reference to: nitrosamines in nitrite-cured meat or fish products; nitrite formation in the stomach; the importance of nitrites in the control of Clostridium botulinum in foods; the role of nitrites in flavour formation in cured meats; use of nitrite in combination with ascorbic acid; problems of

31

Changes in nitrate and nitrite content, and search for nitrosamines in storage-abused spinach and beets.
Heisler, E. G.; Siciliano, J.; Krulick, S.; Feinburg, J.; Schwartz, J. H.
Journal of Agricultural and Food Chemistry 22 (6) 1029-1032 (1974) [20 ref. En] [Agric. Res. Service, USDA, Regional Res. Center, Philadelphia, Pennsylvania 19118, USA]

Conditions favouring formation of nitrosamines, simultaneous presence of nitrite and secondary amines at acid pH, can occur during abusive storage of comminuted fresh spinach or beets. Shredded spinach, shredded or ground fresh beets, or beet juice rapidly produced nitrite. 1 beet sample contained 1000 ppm nitrite after 2 days at room temp. and still appeared edible. Shredded fresh spinach samples were considered inedible when nitrite level reached 300-500 ppm. Whole fresh and all forms of processed spinach and beets accumulated little nitrite even though containing 1500-2000 ppm nitrite orginally. Selections from these tests, cooked and uncooked, and thawed, frozen, and thawed spinach were analysed by GLC-MS for 6 nitrosamines (methyl-, ethyl-, and methylethylnitrosamine, nitrosopyrrolidine, nitrosomorpholine, and nitrosopiperidine). Results were negative, indicating no detectable formation of these 6 nitrosamines when fresh or processed spinach or beets are stored even beyond the point of edibility. AS

32

Nutritional value of industrially dried fish meals. [Conference proceedings]
Myklestad, O.
IV International Congress of Food Science and Technology 7a, 44-46 (1974) [En] [Norwegian Herring Oil & Meal Ind. Res. Inst., Bergen, Norway]

The influence of processing conditions on the thermal efficiency of fish meal production and retention of the nutritional value was studied. Fish was cooked, pressed, dried to about 10% moisture and ground; comparisons were made between 2 industrial plants using direct rotary driers and drying conditions were also varied. Products were evaluated chemically and in feeding tests on rats and chicks. Process variations were: drying air inlet temp. 410°-1065°C, product temp. 60°-94°C, production rate 1275-12 310 kg/h, estimated residence time 10-15 min. Thermal efficiency improved steadily with increasing production rate. Losses of total protein (Kjeldahl) were <2% but reduction of digestibility could reach 20%; digestibility was improved by chemical preservation of the fish. Some reductions of fat content and possible lipid-protein binding and reduced lipid oxidation were observed. Under some conditions, particularly with chemical preservation, the potentially toxic N-nitrosodimethylamine was detected. The net protein utilization (NPU) and protein efficiency ratio (PER) of the meal were reduced by ≤6% and ≤22% for chicks; for rats the growth rate was reduced by ≤7.5%, but with little change in NPU or apparent digestibility. ELC

33

[Pigments of salted meat and nitrosamines: formation and composition.]
Frouin, A.; Thenot, M.; Bazile, J.
Industries Alimentaires et Agricoles **91** (11) 1425-1431 (1974) [39 ref. Fr, de, en]

Binding of NO to meat pigments was studied in relation to nitrosamine. Strong covalent binding of NO, disruption of the haem/globin bond and fixation of reducing compounds were demonstrated. Compounds referred to as nitrosomyoglobin, nitrosohaemoglobin, nitrosomyochromogen and nitrosohaemochromogen are in effect a single compound (nitrosaem). Inhibitory effects of haem pigments on nitrosamine formation (as a result of covalent binding of NO) are discussed. RM

34

Method of elimination of nitrosamines from meat curing agents. [Conference proceedings]
Sen, N. P.; McKinley, W. P.
IV International Congress of Food Science and Technology 9c, 27-29 (1974) [En] [Food Directorate, Health Production Branch, Ottawa K1A OL2, Canada]

Studies have been carried out on the formation of N-nitrosamines in premixes containing ground spices and nitrite. Dimethylnitrosamine, nitrosopyrrolidine and nitrosopiperidine were detectable in some samples. Trace quantities of these nitrosamines were detected in Mettwurst and Thuringer sausages made with such premixes. The identity of these nitrosamines was confirmed by combined gas-liquid chromatographic-mass spectrometric analysis. When spices and nitrite were kept separate until added to the sausage mix, no detectable amounts of nitrosamines were found. AS

35

[Production of boiled sausages. Colour formation.] Brühwursttherstellung. Grundlagen der Farbbildung.
Wirth, F.
Fleischwirtschaft 55 (1) 17-20 (1975) [De] [Bundesanstalt für Fleischforschung, 8650 Kulmbach, Federal Republic of Germany]

Factors influencing colour formation in boiled sausages are discussed, including: supplementation with haemoglobin; curing salts; colour reactions of myoglobin; pH; comminution under vacuum or in an N_2 atm.; vacuum or inert gas packaging; storage temp.; illumination; packaging materials; and ascorbic acid. Nitrosamine formation is also briefly discussed. RM

36

The occurrence of volatile amines in uncured and cured pork meat and their possible role in nitrosamine formation in bacon.
Patterson, R. L. S.; Mottram, D. S.
Journal of the Science of Food and Agriculture **25** (11) 1419-1425 (1974) [22 ref. En] [Agric. Res. Council, Meat Res. Inst., Langford, Bristol BS18 7DY, UK]

The concn. of volatile amines were determined in the eye muscle of 10 pork carcasses immediately after slaughter, before curing, after maturation and after vacuum-packed storage of the bacon. Methylamine (MA), dimethylamine (DMA), trimethylamine (TMA), ethylamine (EA), diethylamine (DEA), n-propylamine (n-PA) and isopropylamine (iso-PA) were detected by gas chromatography; MA was present in greatest concn. (≤1900 μg/kg), the concn. of the others being considerably less. During bacon manufacture the concn. of DMA, TMA, n-PA and iso-PA increased consistently up to the end of the maturation period, despite the presence of nitrite both in brine and in bacon; in subsequent storage only DMA and TMA continued to increase. MA decreased during curing and maturation, and then remained unchanged; EA and DEA were unchanged throughout at very low levels. The mean value for DMA concn. was <200 μg/kg before curing; higher values (max. 520 μg/kg) were found in vacuum packed stored bacon. No nitrosamines were found above the detection limit (1 μg/kg) in any of the uncooked pork or bacon. AS

37

dentification of γ-butenyl-(β-propenyl)nitrosamine, he principal volatile nitrosamine formed in the itrosation of spermidine or spermine.
Hildrum, K. I.; Scanlan, R. A.; Libbey, L. M.
Journal of Agricultural and Food Chemistry **23** (1) 34-37 (1975) [13 ref. En] [Dept. of Food Sci. & Tech., Oregon St. Univ., Corvallis, Oregon 97331, USA]

The principal volatile N-nitrosamine formed in the nitrosation of spermidine or spermine [polyamines which have been found in barley and wheat, soybean flour, and pork] at pH 3.5 and 80°C was γ-butenyl-(β-propenyl)nitrosamine. Its structure was confirmed by synthesizing γ-butenyl-(β-propenyl)amine and nitrosating it to form the corresponding nitrosamine. The mass, IR, and NMR spectra of the nitrosamine from spermidine or spermine were identical with the spectra obtained from the synthesized γ-butenyl-(β-propenyl)nitrosamine. AS

38

Influence of ascorbic acid and pH on the formation of N-nitrosodimethylamine in cured pork containing added dimethylamine.
Mottram, D. S.; Patterson, R. L. S.; Rhodes, D. N.; Gough, T. A.
Journal of the Science of Food and Agriculture **26** (1) 47-53 (1975) [19 ref. En] [ARC Meat Res. Inst., Langford, Bristol, UK]

Under laboratory conditions simulating normal bacon curing, the conversion to N-nitrosodimethylamine (NDMA) of dimethylamine (DMA) added to pork was 0.1%. Addition of sodium ascorbate to the brine was shown to suppress NDMA formation from added DMA in this simulated curing system and in experimental curing of pork middles spiked with DMA. Heating, by canning or frying, resulted in the formation of small amounts of NDMA in the lean and considerably higher concn. in the fried fat. However, the lowest amounts of NDMA were found in the bacon cured in the presence of ascorbate. AS

39

Effect of nitrite and other factors on the physico-chemical characteristics and nitrosamine formation in bacon. [Conference proceedings]
Herring, H. K.
Proceedings of the Meat Industry Research Conference pp. 47-60 (1973) [12 ref. En] [Armour & Co., Food Res. Lab., Oak Brook, Illinois 60521, USA]

Brief details are given of studies on the effects of added nitrite (≤170 ppm) and vacuum packaging on the composition and quality of bacon and the effects of added nitrite (≤170 ppm), ascorbate or isoascorbate (≤2000 ppm) and meat storage before processing on nitrosopyrrolidine formation in fried bacon. Tables of results are given. Residual nitrite and nitrate concn. increased and colour, flavour and shelf-life improved with increasing levels of added nitrite. Nitrite delayed growth of bacteria and moulds; this effect was more marked with high levels of added nitrite. Vacuum-packaged bacon had a longer shelf-life than non-vacuum packaged samples. Uncooked bacon contained no nitrosopyrrolidine. In cooked samples, the nitrosopyrrolidine concn. increased with increasing level of added nitrite. Pan frying gave the highest nitrosopyrrolidine concn., followed by oven baking. Microwave cooking gave relatively low nitrosopyrrolidine concn. Addition of high concn. of ascorbate or isoascorbate almost completely prevented nitrosopyrrolidine formation in fried bacon. Storage of pork bellies before processing had no clear effect on nitrosopyrrolidine formation. AJDW

40

Carbonyl-amine reaction products as possible nitrosamine precursors.
Marshall, J. T., Jr.
Dissertation Abstracts International, B **35** (3) 1289: Order no. 74-19836 (1974) [En] [Michigan St. Univ., East Lansing, Michigan 48823, USA]

Aliphatic imines, synthesized from aldehydes and primary amines, were exposed to sodium nitrite or nitric oxide to determine whether N-nitrosamines would be formed. Sodium nitrite was also added directly to the aldehyde-amine reaction mixture. Nitrosamines were not found in any of the reaction products. Sodium nitrite was incorporated into ground ham, half of which was freeze-dried before heat treatment, and half subjected only to heat treatment. Evidence of nitrosamines was found in samples to which an excessive quantity of sodium nitrite had been added. Freeze-dried meat contained only traces of apparent nitrosamine. PG

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8 C 304
[Formation of nitrosamines. II. Kinetic studies on nitrososarcosine formation from creatine and sodium nitrite.]
Yamamoto, M.; Yamada, T.; Tanimura, A.
Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] **15** (6) 461-468 (1974) [27 ref. Ja, en] [Nat. Inst. of Hygienic Sci., 18-1 Kamiyoga 1-chome, Setagaya-ku, Tokyo, Japan]

The rate of N-nitrososarcosine formation from creatine and sodium nitrite was studied at pH 3.0 and 37°C. The rate = $k \times [\text{creatine}] \times [NaNO_2]$, where the k value was 0.66×10^{-3} $mol^{-1} \times l. \times min^{-1}$. [See FSTA (1975) 7 6C191 for part I.] TM

42

[Presence of nitrates, nitrites and N-nitrosamines in ripened cheese.]

Laskowski, K.; Bierska, J.; Kaminski, J.; Skwarska, S.; Soltys, W.; Szymanska, D.; Dajnowiec, Z.
Roczniki Instytutu Przemysłu Mleczarskiego **16** (2) 63-76 (1974) [19 ref. Pl, ru, en] [Inst. Przemysłu Mleczarskiego, Warsaw, Poland]

In an examination of samples of different cheeses intended for the market throughout Poland carried out during Nov. 1972-Sept. 1973, % of cheeses in which nitrates and nitrites respectively were detected were (numbers of samples examined in parentheses): Edam cheese (256), 15 and 63; Gouda cheese (190), 13 and 61; Tilsit cheese (162), 13 and 56; and Warminski, Podlaski and Salami cheeses (43), 14 and 59. No N-nitrosamines were detected in any of the samples. 5 batches each of Edam, Gouda and Tilsit cheeses were made industrially under the supervision of the Warsaw Dairy Industry Institute with the additon of 20 g saltpetre/100 l. cheese milk; only nitrites were detected in them, in some up to the 12th wk of ripening. SKK

43

[Dimethylnitrosamine in meat products.]

Cantoni, C.; Renon, P.
Atti della Societa Italiana delle Scienze Veterinarie **27**, 574-576 (1973) [9 ref. It, fr, en] [Istituto di Ispezione degli Alimenti di Origine Animale, Univ., Milan, Italy]

A total of 25 samples of meat products (11 samples of cooked ham, 4 samples of cooked shoulder, 4 samples of cooked tongue, 2 samples of 'Wurstel' sausages and 4 samples of salami) was analysed for dimethylnitrosamine (DMN). Ranges of values for DMN concn. in each product (with the number of DMN-positive samples in parentheses) were: ham (8), 0.004-0.025 mg/kg; shoulder (3), 0.021-0.119 mg/kg; tongue (3), 0.018-0.070 mg/kg; and salami (2), 0.028-0.42 mg/kg. Both samples of wurstel were DMN-free. LA

44

Isolation and identification of nitrosoproline in uncooked bacon.

Kushnir, I.; Feinberg, J. I.; Pensabene, J. W.; Piotrowski, E. G.; Fiddler, W.; Wasserman, A. E.
Journal of Food Science **40** (2) 427-428 (1975) [16 ref. En] [USDA, E. Regional Res. Center, Philadelphia, Pennsylvania 19118, USA]

Nitrosoproline (NO-Pro) has been isolated from uncooked bacon. Its volatile methyl ester was prepared by reaction with diazomethane, detected by GLC and identified by GLC-high resolution MS. NO-Pro, which to date has not been found to be carcinogenic, is the first non-volatile nitrosamine found in a food product. The concn. found, 0.38-1.18 mg/kg (ppm), together with information on known convertibility suggest that NO-Pro is a major precursor for nitrosopyrrolidine in fried bacon. IIFT

45

Studies of the metabolism of dimethylnitrosamine in the rat. I. Effect of dose, route of administration and sex.

Phillips, J. C.; Lake, B. G.; Heading, C. E.; Gangolli, S. D.; Lloyd, A. G.
Food and Cosmetics Toxicology **13** (2) 203-209 (1975) [16 ref. En] [British Ind. Biol. Res. Assoc., Woodmansterne Rd, Carshalton, Surrey SM5 4DS, UK]

Since man is known to ingest small quantities of nitrosamines in food, particular attention has been paid in this study to the oral route of administration. Existing data on the dose-dependent rate of metabolism of dimethylnitrosamine (DMN) have been extended to concn. down to 0.1 mg/kg. Rate of metabolism appeared to be related to dose over the entire range studied (0.1-50 mg/kg), and immature animals metabolized DMN at a significantly higher rate than mature animals of the same sex. Rate of metabolism was similar for all 3 parenteral routes of injection, but was significantly lower after oral administration. Results of gastro-intestinal absorption studies are also presented. VJG

46

[Contents of nitrates, nitrites and nitrosamines in 3 types of cheese, Edam, Gouda and Tilsit.]

Przybylowski, P.; Kisza, J.; Dajnowiec, Z.
Przemysl Spozywczy **29** (1) 9-12 (1975) [16 ref. Pl, ru, en, fr, de] [Inst. Inzynierii i Biotech. Zywnosci, ART, Olsztyn, Poland]

Contents of nitrates, nitrites and nitrosamines were determined in 141 random samples of cheese supplied at the rate of 2-4/month for 10 months (Nov.-Aug.) by 10 cheese factories. Ranges for nitrates in mg/100 g were respectively: Edam, 0.093 (Nov.)-0.316 (Feb.); Gouda, 0 (June)-0.345 (Jan.); and Tilsit, 0.062 (March)-0.301 (Feb.). Corresponding ranges for nitrites were: Edam, 0 (March)-0.14 (June); Gouda 0 (May, June)-0.118 (July); and Tilsit 0 (March)-0.125 (April). 2nd order regression equations calculated for the 3 cheese varieties indicate nitrate max. in Feb.-April, and corresponding nitrite min. High nitrite values in June-Aug. are ascribed to summer additions of KNO_3 to cheese milk in excess of those prescribed. 31 of the 141 cheese samples gave a positive nitrosamine colour reaction in June-Aug. SKK

47

Effect of added sodium nitrite and sodium nitrate on sensory quality and nitrosamine formation in thuringer sausage.
Dethmers, A. E.; Rock, H.; Fazio, T.; Johnston, R. W.
Journal of Food Science **40** (3) 491-495 (1975) [13 ref. En] [Swift & Co., Res. & Development Center, Oak Brook, Illinois 60521, USA]

The effects of added sodum nitrite and sodium nitrate on sensory qualities and nitrosamine formation in fermented thuringer sausage were investigated. Thuringer was stored under selected temp. and time conditions and tested fresh, fried and baked. Trained sensory panels indicated that flavour and appearance qualities were improved with 50 ppm added nitrite and that desirable flavour and appearance characteristics were obtained with 100 ppm or more added nitrite. Added nitrate produced detectable improvements only in the absence of nitrite. No nitrosamines were detected in thuringer regardless of added nitrite, added nitrate, storage condition, or kitchen preparation method. IFT

48

[Nitrate/nitrite in cheese: toxicology, effect and analysis.]
Brathen, G.
Meieriposten **64** (8) 243-248 (1975) [26 ref. No] [Meierilab., Oslo, Norway]

Although use of nitrates and nitrites in foodstuffs has been prohibited in Norway since 1 Jan. 1973, use of ≤15 g KNO_3/100 l. cheesemilk is still permitted under a special exemption. The author considers various aspects of the nitrates/nitrites problem, in particular the main food sources of nitrates (vegetables) and nitrites (meat products), the formation of nitrosamines, possible alternatives to nitrate for controlling butyric acid fermentation in cheese, the nitrate and nitrite content of the final cheese, and methods of analysis. ADL

49

Formation of N-nitrosopyrrolidine from proline and collagen.
Gray, J. I.; Dugan, L. R., Jr.
Journal of Food Science **40** (3) 484-487 (1975) [20 ref. En] [Dept. of Food Sci. & Human Nutr., Michigan St. Univ., East Lansing, Michigan 48824, USA]

Proline and collagen as potential N-nitrosopyrrolidine (N-Pyr) precursors were investigated in model system studies. Proline in the presence of sodium nitrite was decarboxylated in low moisture carboxymethylcellulose (CMC) systems at elevated temp. to procedure N-Pyr, max. formation occurring at 180°C. Collagen when heated with nitrite in a CMC system at 200°C or in an oil-water system simulating the frying of bacon produced N-Pyr. Confirmation was achieved by gas chromatography-MS. Connective tissue of a cured, smoked ham was also shown to be a precursor of N-[illegible] nitrite. IFT

50

Dual column gas chromatographic system for use in mass spectral determination of nitrosamines.
Gough, T. A.; Sugden, K.
Journal of Chromatography **109** (2) 265-269 (1975) [16 ref. En] [Lab. of Govt. Chemist, Stamford Street, London SE1 9NQ, UK]

A packed gas chromatographic column and a support coated open tubular (SCOT) column are connected in series. Between the columns are 2 micro-vol. switching valves, one enabling solvent to be vented. Short retention nitrosamines are passed through both columns, whereas longer retention nitrosamines by-pass the SCOT column by means of the other switching valve. The GC peak switching facility enables large volumes of extracts of foodstuffs to be injected without adversely affecting the performance of the SCOT column and the mass spectrometer. During examination of a wide range of foods the most frequently occurring nitrosamines were N-nitrosodimethylamine and N-nitrosopyrrolidine. AL

51

Environmental factors in the origin of cancer and estimation of the possible hazard to man. [Review]
Jones, H. B.; Grendon, A.
Food and Cosmetics Toxicology 0130 (2) 251-268 (1975) [33 ref. En] [Donner Lab., Lawrence Berkeley Lab., Univ. of California, Berkeley, California, USA]

Stages in the development of cancer and dose-effect relationships with respect to carcinogenesis are discussed. Examples of the estimation of cancer risk which are presented include current problems of exposure of man to low levels of diethylstilboestrol, nitrosamines and radiation. VJG

52

Effect on guinea-pigs of feeding nitrosomorpholine and its precursors in combination with ascorbic acid.
Akin, F. J.; Wasserman, A. E.
Food and Cosmetics Toxicology **13** (2) 239-242 (1975) [15 ref. En] [USDA, Agric. Res. Service, E. Regional Res. Center, Wyndmoor, Pennsylvania 19118, USA]

The presence of ascorbic acid or ascorbate in the stomach has been shown to prevent the hepatotoxicity resulting from the ingestion of secondary amines plus nitrite. Nitrosamine toxicity and the nitrosation process were studied in guinea-pigs, which resemble man in requiring a daily intake of ascorbic acid, by administering nitrosomorpholine (70 mg/l. drinking water) or morpholine (6.33 g/kg food) plus sodium nitrite (1.0 g/l. drinking water) and feeding a diet containing either a high or low level of ascorbic acid or no ascorbic acid. Animals receiving the nitrosamine precursors together with ascorbic acid were not affected, but precancerous liver changes occurred in those receiving nitrosomorpholine together with high or low levels of ascorbic acid. Man and other spp. requiring dietary sources of ascorbic acid may have a built-in protection against in vivo nitrosation. VJG

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Food Group and Microbiology, Fermentation and Enzyme Technology Group Symposium.
[Conference proceedings]
United Kingdom, Society of Chemical Industry, Food Group; **United Kingdom**, Society of Chemical **United Kingdom**, Microbiology, Fermentation & Enzyme Technology Group; **UK**, Institute of Food Science & Technology
Journal of the Science of Food and Agriculture **26** (3) 379-384 (1975) [En]

Summaries are given of papers presented at this symposium which was held jointly with the Institute of Food Science and Technology in London on 13 March 1975. They are: Naturally occurring nitrate/nitrite in foods, by R. Walker (pp. 379-380, 11 ref.); The contribution of nitrite and nitrate to the colour and flavour of cured meats, by D. B. MacDougall, D. S. Mottram & D. N. Rhodes (p. 380); The microbiological effects of nitrate and nitrite [in cured meats], by T. A. Roberts (pp. 380-381); The toxicology of nitrate, nitrite and nitrosamines, by P. F. Swann (pp. 381-382); The formation and analysis of N-nitrosamines, by J. K. Foreman & K. Goodhead (pp. 382-383); Formation of C- and S-nitrosation products and their further reactions, by J. Gilbert, M. E. Knowles & D. J. McWeeny (pp. 383-384, 5 ref.); and The analysis of nitrate and nitrite in foodstuffs: a critical review, by C. D. Usher & G. M. Telling (p. 384). JA

54

Formation of heterocyclic N-nitrosamines from the reaction of nitrite and selected primary diamines and amino acids.
Warthesen, J. J.
Dissertation Abstracts International, B 35 (7) 3382: Order no. 74-29739 (1975) [En] [Oregon St. Univ., Corvallis, Oregon 97331, USA]

The reaction of primary amines with nitrite was investigated with regard to the formation of N-nitrosamines. In low moisture systems at 160°C various primary amine hydrochlorides yielded nitrosamines. Putrescine and cadaverine gave over 20% of nitrosopyrrolidine; ornithine, lysine and butylamine gave various nitrosamines with lesser yields. In aqueous buffered solutions at temp. up to 100°C similar compounds were formed. The reactions are influenced by pH, type of buffer, nitrite concn. and temp.; the reaction rate appears to be second order in respect of nitrite concn. In a system similar to the frying of bacon at 177°C in the presence of 200 ppm nitrite, 109 ppb nitrosopyrrolidine was formed; this figure was trebled if 0.4% putrescine was also added. FSB

55

N-nitrosamines in foods.
Scanlan, R. A.
CRC Critical Reviews in Food Technology 5 (4) 357-402 (1975) [197 ref. En] [Dept. of Food Sci. & Technol., Oregon St. Univ., Corvallis, Oregon, USA]

N-nitrosamines are an extremely hazardous class of compounds. The possibility of the occurrence of these compounds in our food and in other environmental situations has caused concern over the past decade. This review examines the literature which provides an understanding of the chemistry of N-nitrosamine formation. Particular attention is paid to the more recent reports concerning methodology for determining N-nitrosamines and to the reports since 1970 on the occurrence of N-nitrosamines in foods. The literature concerning factors which influence N-nitrosamine formation in foods is evaluated and discussed. AS

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Degradation of N-nitrosamines by intestinal bacteria.
Rowland, I. R.; Grasso, P.
Applied Microbiology **29** (1) 7-12 (1975) [28 ref. En] [Britisch Ind. Biol. Res. Assoc., Carshalton, Surrey SM5 4DS, UK]

57

[N-alkyl-nitrosamines in Italian and imported cheese.]
Cerutti, G.; Zappavigna, R.; Santini, P. L.
Latte April, 224-227 (1975) [28 ref. It, fr] [Istituto Ind. Agrarie, Univ. di Milano, Milan, Italy]

The N-alkyl-nitrosamine content of 16 cheeses of Italian and foreign origins was determined by TLC and GLC. Dimethyl-, diethyl-, dipropyl- and dibutyl-nitrosamines occurred once each and in 0.02-0.03 ppm amounts in single different cheeses, but 2 other substances, possessing R_f values of 0.35 and 0.48 and giving the characteristic nitrosamine reaction, were found in variable amounts up to 0.06 ppm in most of the cheeses. Identification of these substances, possibly assymetric aliphatic nitrosamines, should be possible by a combination of GLC and MS. Prohibition of the addition of nitrate to milk in view of its role in nitrosamine formation is advocated, especially when the milk is used for cheesemaking. GTP

58

[Passage of carcinogenic N-nitrosamines from the digestive tract into milk.]
Juszkiewicz, T.; Kowalski, B.
Bromatologia i Chemia Toksykologiczna **7** (4) 423-429 (1974) [7 ref. Pl, ru, en] [Zaklad Farmakologii i Toksykologii, Inst. Weterynarii, Pulawy, Poland]

Milking goats were treated with single doses (1-40 mg/kg) of N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA) or N-nitrosodipropylamine (NDPA) by stomach tube. Blood and milk samples were collected from

animals at intervals from 2 to 36 h after treatment, and anylsed for N-nitrosamines by GLC using a thermionic N detector. It was found that oral administration of NDMA, NDEA or NDPA resulted in excretion of N-nitrosamines via the milk for approx. 24-36 h and depended upon the given dose and the chemical structure of the preparation. The highest amounts of NDMA and NDEA were detected 2 h after treatment. Even following the administration of as little as 1 mg/kg, detectable amounts of N-nitrosamines were found in the milk (0.003 mg/kg at 2 h). Blood levels were somewhat higher or equal to the corresponding levels in milk. AS

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